DESY Summer Student Program 2007

Dilepton SUSY studies with ATLAS

$$\chi_1^0$$

thanks to the whole group especially to Johannes, Wolfgang and Karsten

Simone Hamerla

Why supersymmetry?

- SM describes most phenomena
- But:
  - no reason for amount of particles
  - no Grand Unification Theory (GUT)
  - hierarchy problem:

    electroweak scale $m_W << m_P = 10^{19}$ GeV

  - dangerous corrections to higgs mass

→ needs same interaction with opposite sign

boson ↔ fermion

boson ⇔ fermion

- new **s**particles

lepton number

change spin by ½ → **s**electron S = 0
gluino S = 1/2

analogue to L, B: R parity conserved

$$R = (-1)^{3B+L+2S}$$

consequences: -only sparticle pairs

-must be stable LSP (Lightest Supersymmetric Particle)

- χ_1^0 neutralino good candidate for cold dark matter

SUSY not exact symmetry:

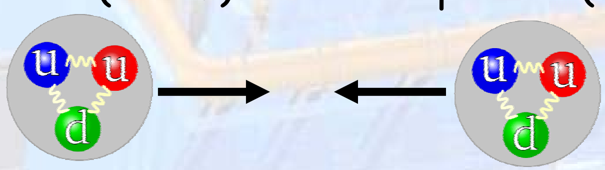
→ sparticles must be heavier than particle
because no sparticle seen yet

→ Symmetry breaking by gravitino (mSugra model)

higher mass means one needs more energy / new colliders

like the LHC Large Hadron Collider

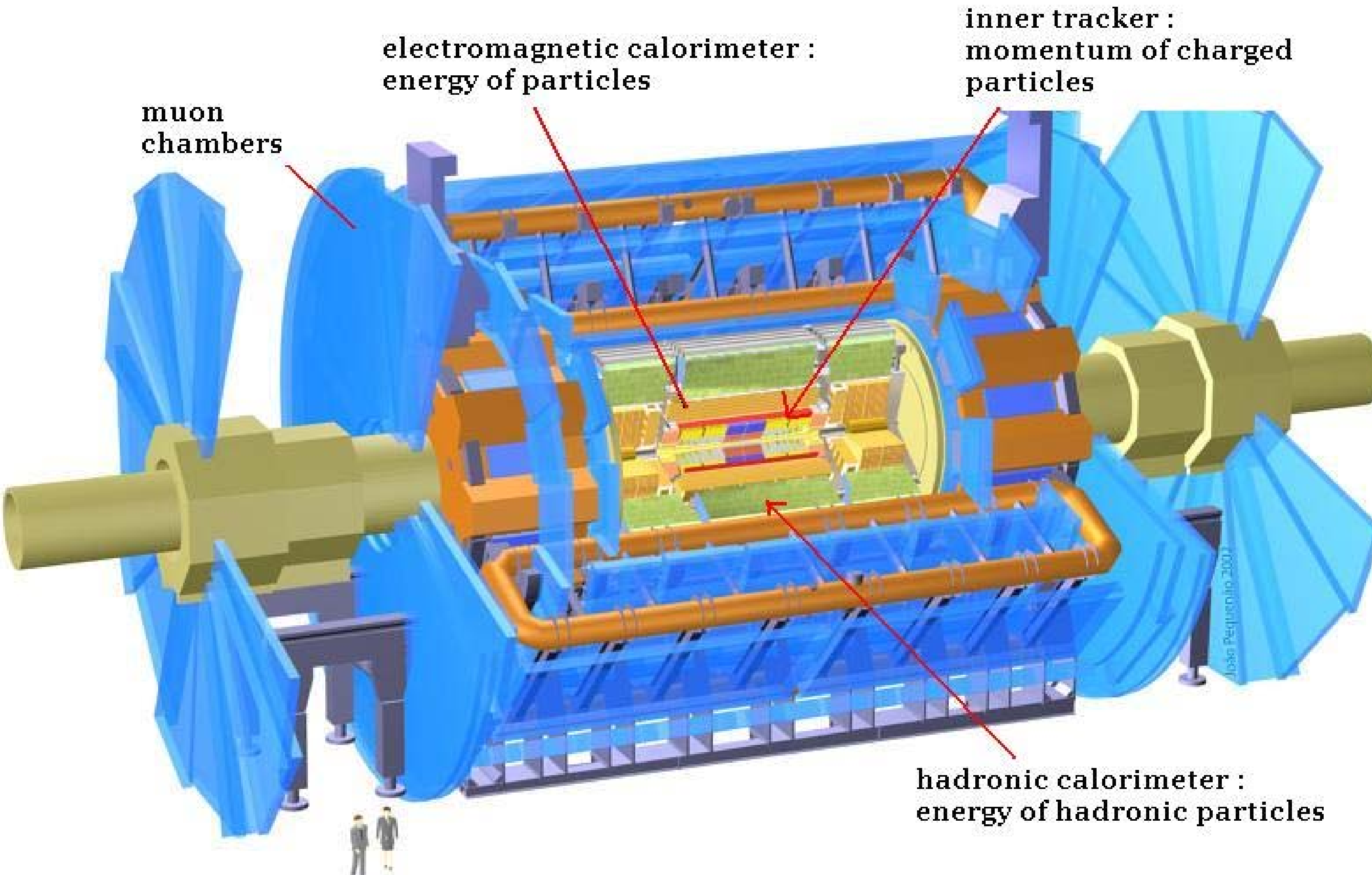
proton (7TeV) proton (7TeV)



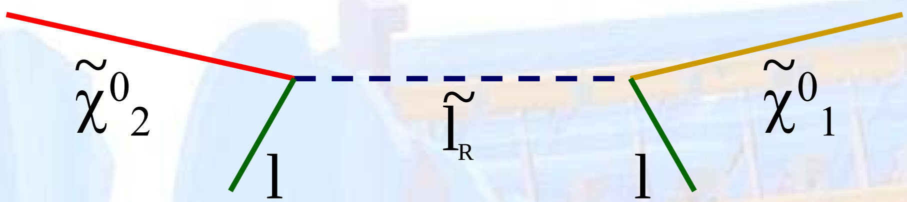
Distribution in proton : primary sparticles mainly squark/squark squark/antisquark
gluino/squark gluino/antisquark

Atlas detector

(A Toroidal LHC AparatuS)



χ_1^0 escapes → indirect measurements



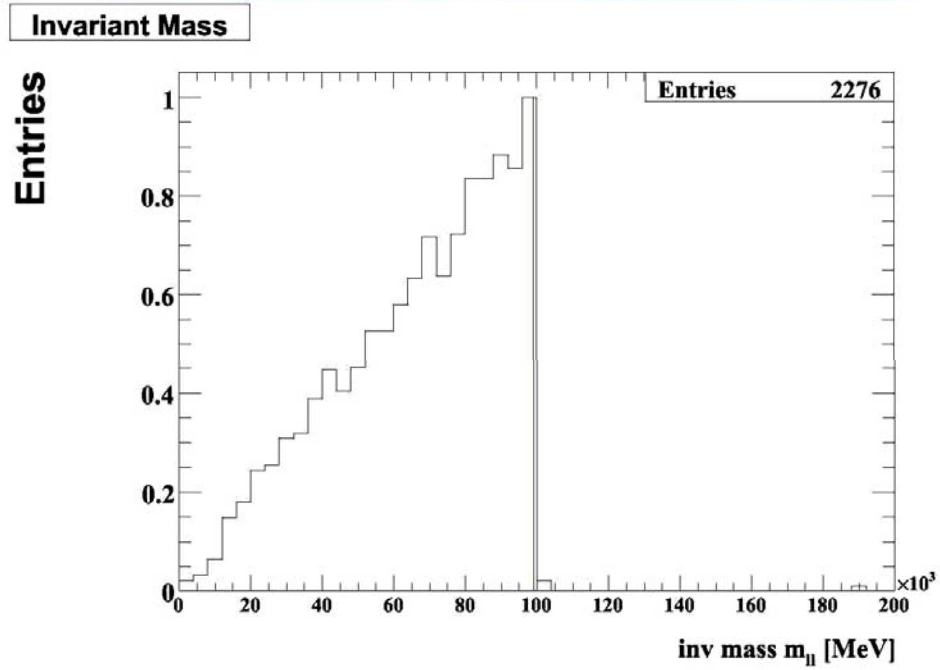
good because: two leptons / easy reconstruction

ignore taus because reconstruction more difficult

from invariant mass you get mass difference between the two neutralinos

$$m_{ll} \approx m_{\chi_2^0} - m_{\chi_1^0}$$

triangle with sharp edge



use generator information to plot invariant mass of leptons with all requirements

can be calculated from generated masses

$$m_{ll} \approx 100\mathrm{GeV}$$

all based on generator information: know mother/daughter/type etc.

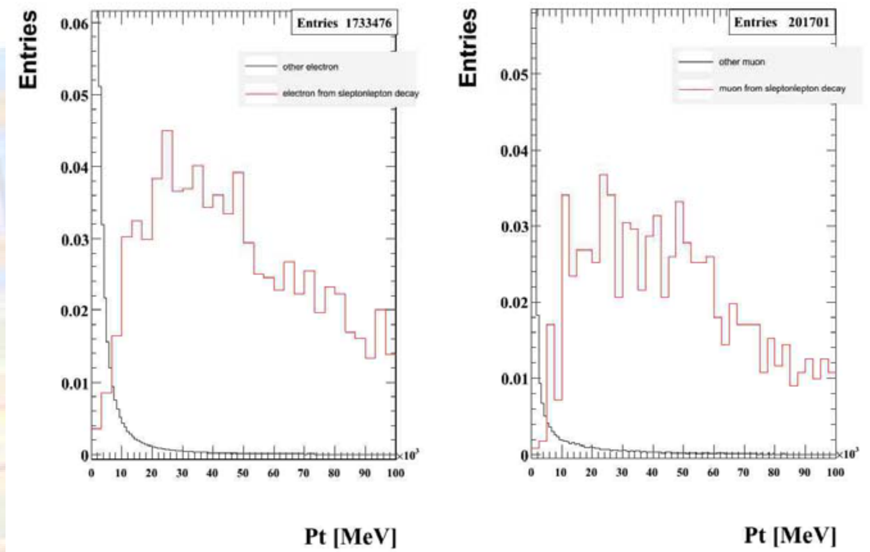
How can we identify leptons on real data?

try method on truth generator data

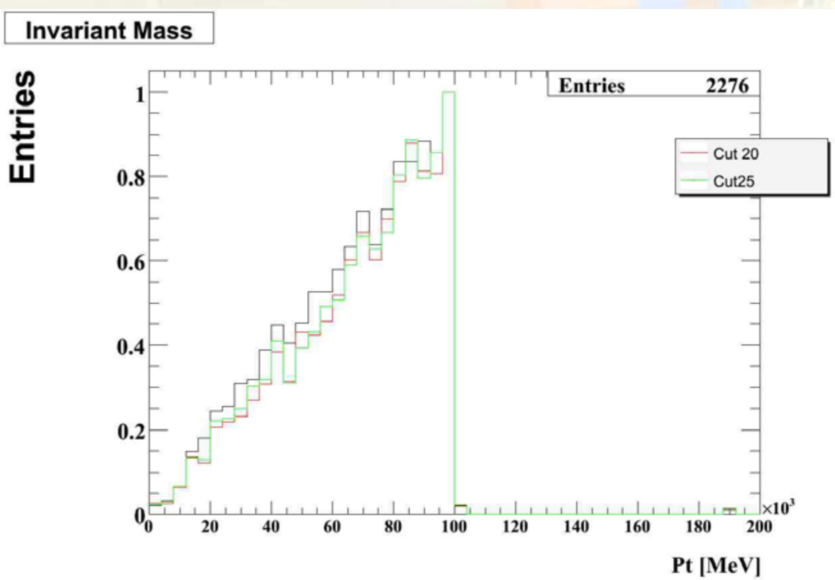
detector provides:

particle identification

kinematic properties as p_T



cut at 10 or 20 GeV suppresses background

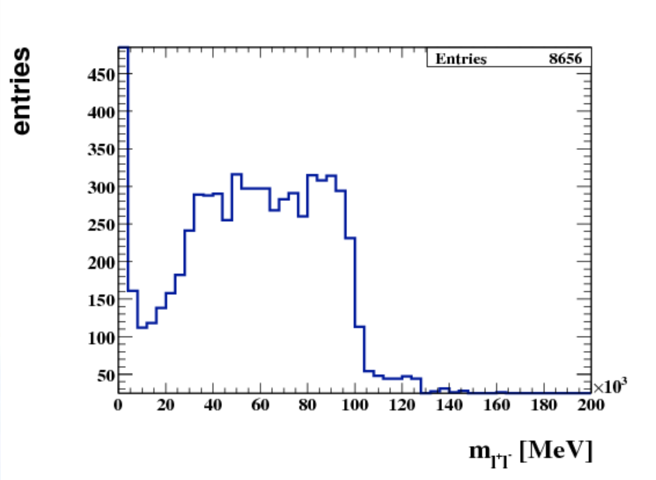


Influence of cut on inv. mass

changes height but not shape

edge survives cut

now try reconstructed data

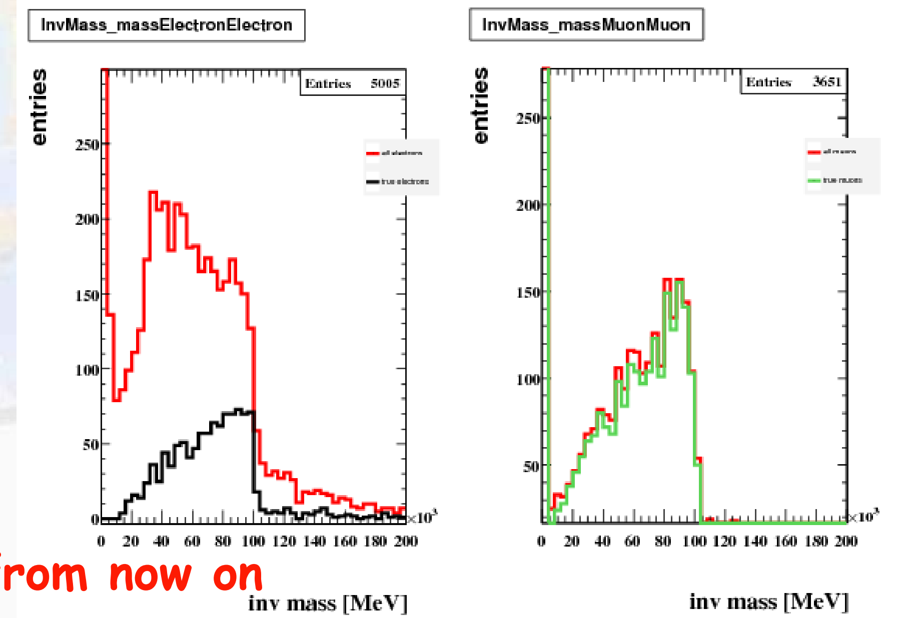


- use electrons and muons
- opposite sign same flavour OSSF
- highest transverse momentum

$\eta < 2.5$

- still influence of other particles faking leptons

compare muon and electron

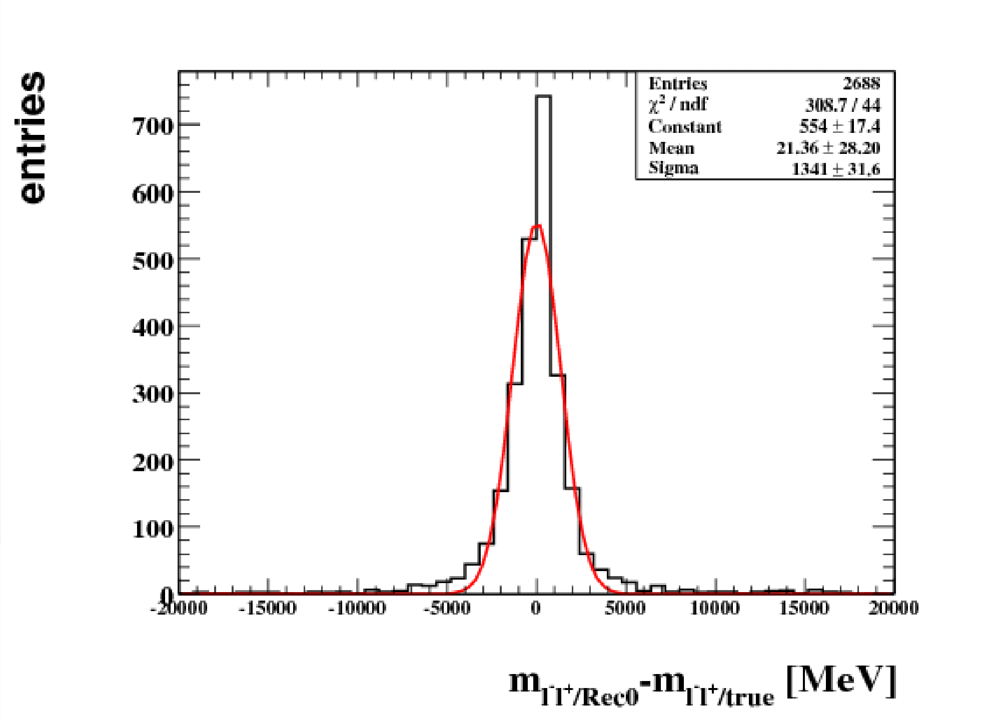


more faked electrons
than muons
take only muons from now on

although nice triangular shape for muons

still effects from detector resolution

Resolution for invariant mass



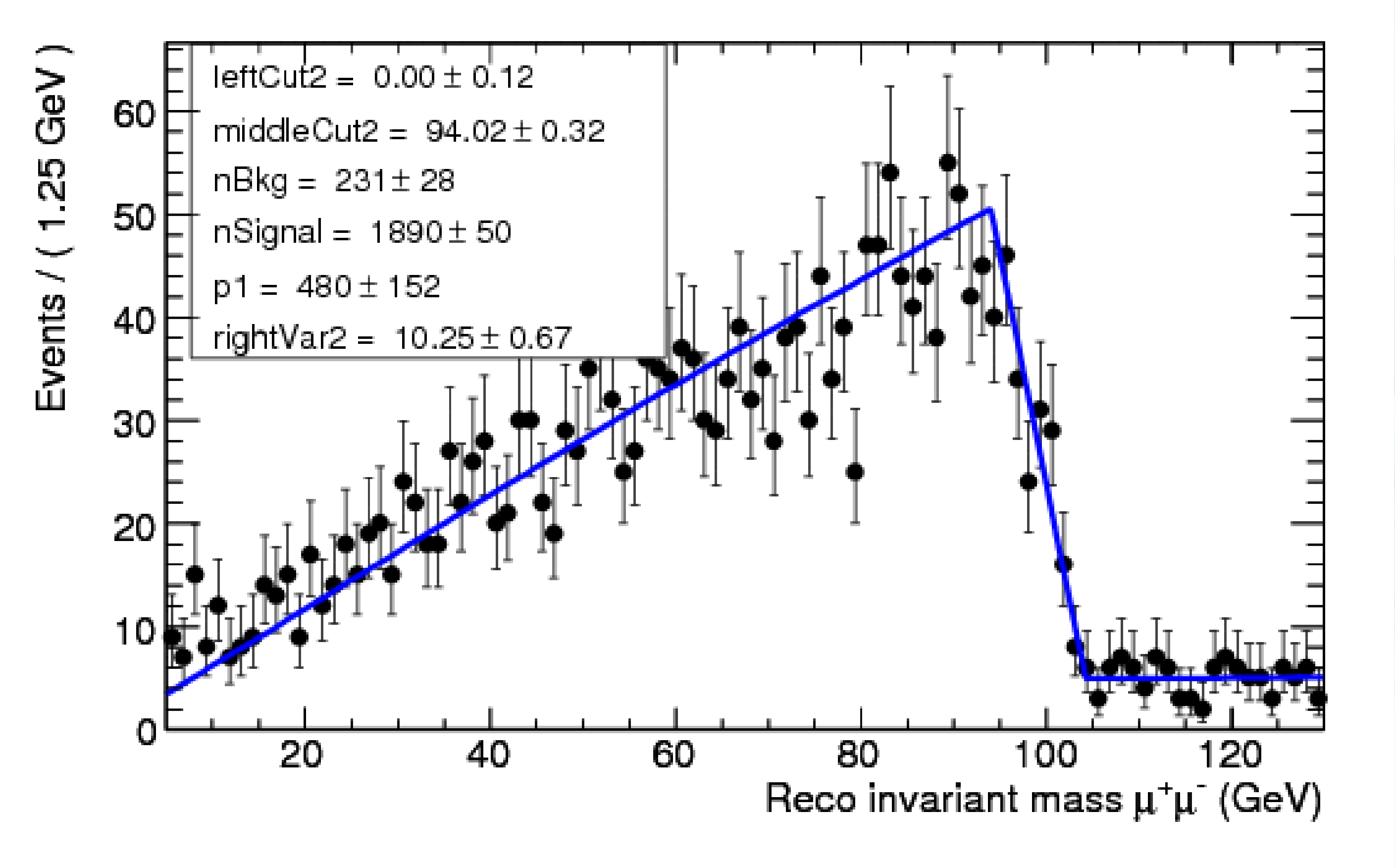
gaussian function with width of 1.34 GeV

- invariant mass smeared out
- more points move to upper part of edge than down

fit convolution of gaussian function and triangle

expected to be in middle of edge :

$$m_{ll} \approx (99.15 \pm 0.46)\,\text{GeV}$$



Conclusion:

- faking electrons easier than faking muons
- with muon good triangular shape can be received using:
  - p_T cut
  - convolution with gaussian function

calculated mass difference	received mass difference
100 GeV	99.15 GeV

- data correspond to luminosity of 672pb^{-1}
- could be reached after 3 months


Let's wait what future will bring!